PLAN

SECTION 1

An investigation into which surface of a leaf transpires more by transpiration.

Brief statement of investigation

I am going to investigate which surface of a leaf loses more water by transpiration. I will do this by covering certain sides in a layer of Vaseline. The Vaseline will prevent transpiration occurring on that particular side allowing me to see which side transpires more.

Risk assessment

The number of risks in this assessment is minimal but the following risks will be present:

- Any leaves must not be consumed
- Extreme care must be taken when handling glass Vaseline pots
- Paper clips must be handled with care and must not be uncoiled
- All personal property should be tucked away while the experiment is being carried out

Independent variable

The surface(s) covered by Vaseline i.e. topside or underside.

Dependent variable

The amount of transpiration that occurs from a particular surface and therefore the amount of weight lost due to transpiration from one particular surface.

Number and range of readings

I will be making one reading for each leaf after about 20 hours.

SECTION 2

Prediction

I predict that the underside of the leaf will transpire more. I also predict that the amount of transpiration that occurs from the two leaves with one surface vaselined will be roughly the same as the amount that occurs from the leaf with neither of its side's vaselined.

Scientific reason for prediction

The reason for my first prediction is that the underside is covered in stomata pores, making it possible for water to leave the leaf when the pores are open. On the topside however, there are no pores, just a waxy layer instead. This means that almost no water can leave the leaf via this particular surface. The process of evaporation through the stomata means that the plant can easily control the amount of water that it releases into the environment. The reason for my second prediction; that the percentage weight loss from leaves 1 & 2 will add up to that of 4, is because leaf 1 has its topside vaselined, preventing transpiration from that surface and leaf 2 has its underside vaselined preventing transpiration from this surface, whereas leaf four has none of its surfaces vaselined so in theory they should add up.

Transpiration only occurs when the cells in the leaf are turgid causing the pores to open up, but certain factors affect the rate at which transpiration occurs. One of these factors is sunlight. Therefore, if leaves had their stomata on the topside, the sunlight would speed up the rate of transpiration, disrupting the plants control. This could be a reason why the plant has the stomata on the shady underside of the leaf, and therefore, a reason why more transpiration occurs from the underside of the leaf.

Diagram

List of equipment

4 similarly sized dogwood leaves
4 paperclips
Line (to hang leaves on)
Tub of petroleum jelly
Weighing scales (accurate to 0.01 of a gram)
A2 sheet of paper

Fair test

To ensure that my investigation is a fair test, I will:

- Put all four leaves in a place where temperature, humidity, air current and amount of sunlight are all exactly the same.
- Weigh each leaf before and after vaselining to obtain a weight for the Vaseline. I will then subtract this from the end weight to find out how much weight the leaf has lost.
- Spread the Vaseline as equally and thinly as possible because this will cut down the percentage error
- Have two test leaves to check whether or not the test has been fair, one with Vaseline on both sides to check whether the leaf can still transpire or not, and one with no Vaseline to see whether the amount of transpiration from this leaf adds up to the total amount of transpiration that occurs from the leaves with one of their sides vaselined.

  As I mentioned in the scientific reason for prediction, the amount of sunlight that the underside of the leaf receives could have a big impact on the outcome of my experiment. This may mean that I should point my leaves so that the topside faces the sun because this is how it would naturally be in nature. If I pointed the underside of the leaf towards the sun, I may find that it transpires excessively and that the topside. Whereas if I point the topside towards the sun, the topside will transpire slightly, if very minimally, and the underside will still transpire more than the topside but less than it would if it were facing the sun.

SECTION 4

Information from secondary sources/preliminary work

Preliminary will not be carried out because of a lack of time. However if I did carry some out, I would have had a much better idea of what I might expect my results to be. However I do know (from various books) about the structure of the leaf and I can see from this that the underside of the leaf is much more likely to be the side that the most transpiration occurs from.

OBTAINING EVIDENCE

Results table

MEASURING STAGE / LEAF + SURFACE VASELINED	WEIGHT BEFORE V.	WEIGHT AFTER V.	WEIGHT AFTER 24 HOURS	TOTAL WEIGHT LOSS	% WEIGHT LOSS	SURFACE AREA
LEAF 1(topside)	0.70 g	0.85 g	0.54 g	0.31 g	44.3	17.14 cm sq
LEAF 2(underside)	0.64 g	0.84 g	0.76 g	0.08 g	12.5	15.66 cm sq
LEAF 3(both)	0.48 g	0.83 g	0.82 g	0.01 g	2.1	11.75 cm sq
LEAF 4(neither)	0.42 g	0.42 g	0.25 g	0.17 g	40.1	10.28 cm sq

V. = VASELINE APPLIED

Detailed method

I picked four leaves from a cutting of a dogwood plant kept in water, and weighed each one. I then covered the topside of one of them in Vaseline, the underside of the second and both of the surfaces on the third. I left the fourth one with no Vaseline on it. I then weighed the leaves again to obtain a weight for the Vaseline on that particular leaf, and hung them up on a line using paperclips. After 24 hours I weighed the leaves again and calculated the total and % weight loss.

ANALYSING EVIDENCE

SECTION 1

Graphs

Section 2

Process data and evidence

The first graph shows that leaf 1 had the highest percentage weight loss followed by leaf 4 and then leaf 2 and 3. This supports my prediction that the underside of the leaf will transpire the most because leaf 1 is the leaf with just the underside showing. However, I did expect leaf three, the leaf with none of its surfaces Vaseline to transpire more than leaf 1 so this is an anomalous result. Also, this graph does not support my second prediction that the percentage weight loss of leaves 1 & 2 should roughly add up to the percentage weight loss of leaf 4 as they add up to a significant amount more. This all suggests that leaf 4 is a large anomaly.

Section 3

Conclusion based on section 1 & 2 above

From my evidence I conclude that more transpiration occurs from the underside of the leaf where the stomata are situated.

Relate conclusion to detailed scientific knowledge

The reason for my conclusion, similar to that of my first prediction since it proved to be right, is that the underside is covered in stomata pores, making it possible for water to leave the leaf when the pores are open. On the topside however, there are no pores, just a waxy layer instead. This means that almost no water can leave the leaf via this particular surface. The process of evaporation through the stomata means that the plant can easily control the amount of water that it releases into the environment. The reason for my second prediction; that the percentage weight loss from leaves 1 & 2 will add up to that of 4, is because leaf 1 has its topside vaselined, preventing transpiration from that surface and leaf 2 has its underside vaselined preventing transpiration from this surface, whereas leaf four has none of its surfaces vaselined so in theory they should add up. However, both of the possible reasons that they don't are probably because of the size and weight of leaf 4. The first possibility is that the leaves can lose as much water as they want through just one surface and water stored in layers of cells on the opposite side of the leaf can still leave it via the other side. So because the larger leaf 1 has more water to lose, it has a larger percentage weight loss. The second reason is that because leaf 4 is so much smaller than leaf 1, it lost as much water as it could before the 12 hours was up whereas leaf 1 was still losing water when I weighed it after 12 hours. Therefore, leaf 1 is able to have a larger percentage weight loss because of its larger size.

Relate to original prediction

My first prediction is strongly supported, however my second is not because of the anomalous result of leaf 4.

EVALUATING EVIDENCE

Accuracy of evidence

Three sets of my results for three leaves were perfectly accurate. However, the other set was not because of the size of leaf four. But the way that the experiment was carried out was as accurate as we could do it without the use of better equipment.

Improvement in accuracy

Greater accuracy could be achieved by using scales accurate to say 0.001 of a gram instead of just 0.01 of a gram, although this would not make any significant differences since the results in this experiment show rough correlation but are not accurate enough to merit a pair of scales of greater accuracy. Also, weighing all the leaves simultaneously on different pairs of scales could very slightly alter the results because with conventional weighing methods the last leaf to be weighed will have perhaps one or two minutes extra transpiration time unless the leaves are weighed in the same order in which they were vaselined, although, like the last improvement that could be made, the experiment will never be accurate enough to merit this and anyway, such a miniscule difference in weight could only be noticed on a pair of incredibly accurate scales because only a couple of minutes of extra transpiration will have taken place.

Anomalous results

The only anomalous result was a major one, that of leaf 4. This one result caused my second prediction to be without strong support, only possible reasons of why the result was anomalous.

Support for a firm conclusion

The only support for a firm conclusion that I have is that my results fit my prediction and I am not sure how accurate my results would be outside a range of 12 hours. I may find that when the leaves are detached from the plant, they each have a limited amount of time during which they can transpire before they lose too much water and have no more of it to lose. This may mean that the thicker, larger leaves will have a longer transpiration period and therefore have a larger percentage weight loss. I am also not sure how true my results will be *inside* a range of six hours.

Improvements to the method

Improvements to the method could be made if each leaf was exactly the same thickness, weight and area so the experiment would be totally fair. However it would be virtually impossible to find such leaves, and no equipment is available to us that allows you to measure thickness. An easier way to make the experiment fairer would be to use an alternative to Vaseline such as thin sticky Perspex to be cut to shape and stuck onto the appropriate side(s). This method would ensure that the thickness of the layer on the leaf would always be constant and none would accidentally scrape off during handling. Also, the leaves should be placed in a draught free environment. Having the draught equal for all four leaves is not good enough unless the draught is

coming from both directions, which it most likely wouldn't be. The direction from which the draught is coming from is important because one leaf may have its vaselined side facing the draught making for an unfair experiment (see diagram).

This is because the draught speeds up transpiration so having a vaselined side and a normal one both facing the draught (i.e. leaf 1 & 2) would result in the normal side receiving a boost from the wind (leaf 1), upsetting the balance. One may argue that if the unvaselined underside is facing the draught and so transpires extra, this is fair since you would expect it to transpire more anyway but we are not only looking for which side transpires more, we are also looking for particular relationships in the amount of transpiration between the leaves. Another way of curing this apart from putting the leaves in a draught free environment would be to point all of the vaselined sides the same way. All of what I have said here also applies to sunlight, and sources of either temperature or humidity. The only reason that we didn't do all this when we were carrying out our experiment was because we didn't think of it. Also, it may be necessary to revise the time period that I leave the leaves to transpire, because some of the smaller leaves may reach the end of their 'transpiration period' and so the bigger, chunkier leaves will have a larger percentage weight loss because they will continue to transpire for longer. A period of around 6 hours may have been a lot more suitable.

Additional evidence

Additional evidence such as results obtained by previous groups carrying out this same experiment would have been useful for me to compare my results with and see if they showed similarities. However, I did not have any previous results so I wasn't able to do this.